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SURFACE WATER TREATMENT IS A BIG CHALLENGE FOR NORTH SINDH - A CASE STUDY OF 18MGD WTP NUMAISHGAH, SUKKUR

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ABSTRACT

To solve the issue of the polluted water supply to Sukkur city, a case study has been taken to assess the quality of the water supplied by 18MGD Water Treatment Plant (WTP) Numaishgah, Sukkur. During the laboratory test, eight parameters were tested. The tests were conducted for a period of ten months from September 2014 through June 2015. In this paper, the performance of WTP is evaluated to assess the quality of water supply at the inlet and outlet of WTP. During the test the maximum values at inlet and outlet for pH of 7.7 and 7.8 respectively were obtained, whereas 360 mg/l and 350 mg/l respectively were measured for TDS, that are within the prescribed limits of 6.5-8.5 for pH and <600 mg/l for TDS suggested by WHO. Furthermore, it has been observed that Escherichia Coliforms is present in every sample of water, which confirms that the water is contaminated by fecal coliforms at the inlet as well as at the outlet. From the study, it is concluded that if the filtration units are rehabilitated, the quality of water can easily be achieved at the outlet of WTP.

Key words: Water treatment, Water supply, Filtration, Numaishgah, Sukkur.

INTRODUCTION

Since the independence of Pakistan, the supply of fresh drinking water has remained a challenge for the concerned authorities, due to the ever growing population [3]. In this regard, a number of measures have been taken till now and those have proved to be very beneficial for the public. Though, still many people are facing problems in acquiring fresh drinkable water.

Water is the necessity of all living things, and thus, in Sindh, the Indus River plays a vital role in the supply of fresh water. But, since the river flows in an alluvial state, the water is not readily consumable [17]. The river also contributes to groundwater, but due to excessive artificial field fertilization, the groundwater is also contaminated. The water from the river is to be treated first so that safe supply of water to the people is ensured.

For the improvement of environmental conditions in Pakistan, the Government of Pakistan started the provincial Planning & Development Departments (P&DD) in 1970. The P&DD Sindh established Municipal Corporations in divisions across the province to regulate the environmental conditions in Sindh. Later on, with the increase in population, the Municipal corporations were found to be not enough to meet the requirements of the public. It was then that the Government was funded by the Asian Development Bank (ADB) [15], and the Sindh Cities Improvement Program (SCIP) was started in the 2000s [14, 15]. The SCIP established Urban Services Corporations (USC) in addition to the existing Municipal Corporations so that the Government can cope up with the loss of environmental regulation [15].

The North Sindh Urban Services Corporation (NSUSC) was established in 2009 and handles the environmental matters such as water supply, wastewater management, and solid waste management for north Sindh [15]. The NSUSC established Water Treatment Plants across Sukkur. At present three water treatment plants located at Bunder road, Airport road and at Numaishgah ground Sukkur are in operation. WTP Numaishgah is situated on rocky stratum as most of the Sukkur City is, and thus, it has to supply water for drinking as well as for other routine activities, while the other two treatment plants i.e. Bunder road and Airport road are situated in areas where groundwater is readily available for routine use, and the said WTPs only supply drinking water [9, 10, 13]. The WTP Numaishgah was established in 2009 as a 2.5MGD plant, but was rehabilitated in 2012 and its capacity was increased to 18MGD [15].

But the problem of contaminated water still persists and most of the public is receiving polluted water in spite of the thorough working of the USCs. The consumption of the polluted water leads to a number of chronic diseases including diarrhea, cholera and dysentery [6].

Here rises the question whether the contaminated water supply in Sukkur city lies in the supply network or in the water treatment plant. According to a study conducted by [10] in 2012, it can be unambiguously inferred that the problem greatly lies within water treatment plants rather than in supply network [1].

Keeping the political, administrative and economic perspectives out, only the environmental engineering perspective has been used in this case study. The performance of the plant has been evaluated to assess the quality of water at the inlet and at the outlet. The results obtained from this study have been compared and benchmarked with the published guidelines on acceptable drinking water quality by the WHO.

OPERATION OF THE 18MGD WTP NUMAISHGAH

The water is pumped from the River Indus into the treatment plant by a number of pumps installed at the Bunder road pumping station. The water is inlet directly into the sedimentation tanks where it stays for a while; in the meantime alum is added. The water is then pumped out directly to the Islamia College distribution reservoir and the Adam Shah Colony distribution reservoir that distribute the water around the city.

In the rehabilitation process, Rapid sand filters, screens, and chlorination plant were established, but these have not been added to the treatment chain of the plant yet.

Samples were collected and tested twice daily at the inlet and at the outlet that are in the sedimentation tank and after the pumps respectively. In this study, a data of about 10 months i.e. from September 2014 to June 2015 has been analyzed.

METHODOLOGY

Table 1 shows the conventional methods of testing water samples as used in the testing of water at the Environmental Engineering lab of 18MGD WTP Numaishgah. Depending upon the measuring instruments available, the following parameters of water quality were able to be tested.

Parameter	Testing Method
Turbidity	Nephelometer
TDS	Conductivity meter
pH	Potentiometer
E. Coliforms	Sulfur-Brath test
Colour	Tintometer
Taste	Physically/Tongue
Odour	Omoscope
R/Chlorine	Horrock's Test

Table 1 | Methods of testing water samples

WHO GUIDELINES

Table 2 provides the water quality parameters with their limits for the acceptable quality of the drinking water published by The World Health Organization [16] in the guidelines for drinking water quality.

Parameter	WHO Standard
Color	< 15 TCU
Taste	Pleasant to taste
Odour	Pleasant to smell
Thermotolerant (Faecal) Coliforms	0
Total Dissolved Solids (TDS)	<600 mg/l
pH	6.5-8.5 [16]
Turbidity	< 5NTU
Chlorine	5 mg/l (Health)

Table 2 | WHO guidelines for drinking water quality

RESULTS & DISCUSSION

a. Turbidity

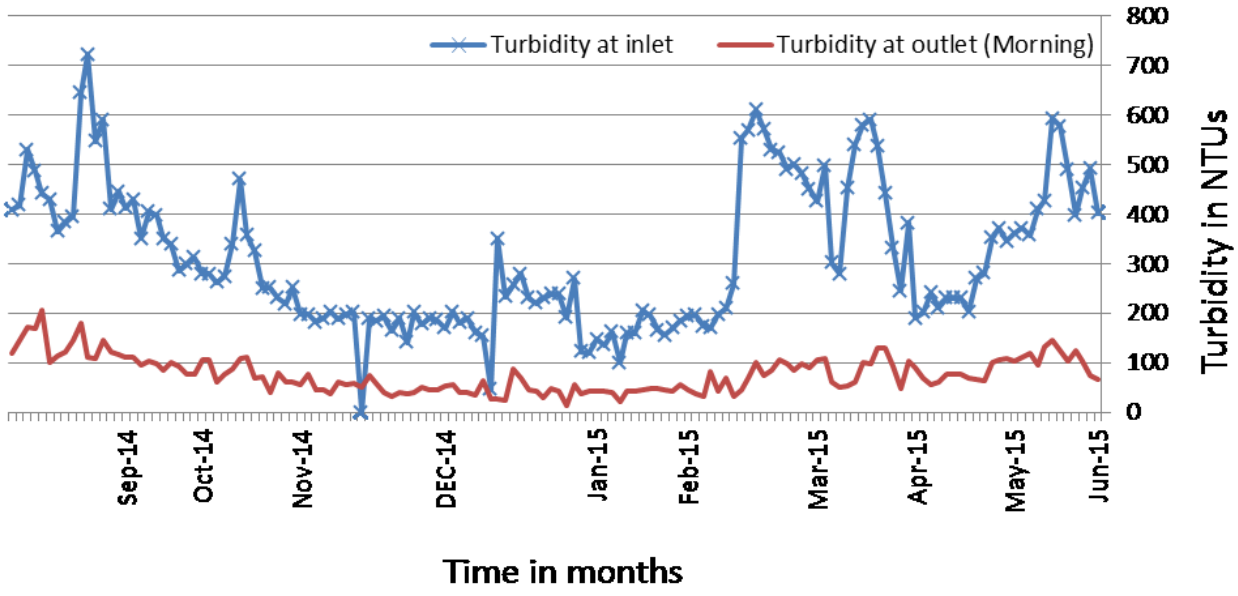

Figure 1 | Variation of turbidity at inlet and outlet of the WTP

Discharge in River Indus is increased in summer and decreased in winter, this affects the quality of water by a slight margin as stated in [17 , 20]

Turbidity is found to be varying in a directly proportional pattern with the discharge in the river. Increased turbidity is an indication of increased discharge in the river, since the increased discharge causes excessive erosion and less silting [17], and the opposite is the case in times of low discharge.

It is thus found that irrespective of the inlet values, the values of turbidity at the outlet are always in the range of 50NTU – 150NTU, which are far beyond the WHO guidelines that allow a maximum turbidity of 5NTU at the outlet [16].

These increased values at the outlet show that a sufficient amount of alum is not added to the water in the sedimentation tanks so as to accelerate the process of coagulation and flocculation [4].

b. Total Dissolved Solids (TDS)

Figure 2 presents the TDS values at the inlet and outlet from September 2014 to June 2015. The figure shows the total dissolved solids are found to be varying in an inversely proportional pattern with the discharge in the river as stated before [17, 20]. It can be inferred that the increased discharge dilutes the total salt concentration of the river.

The values of TDS at the inlet and the outlet are the same and average to about 300mg/l but are unfortunately in the limits of the WHO guidelines that allow a maximum value of 600mg/l TDS at the outlet [16].

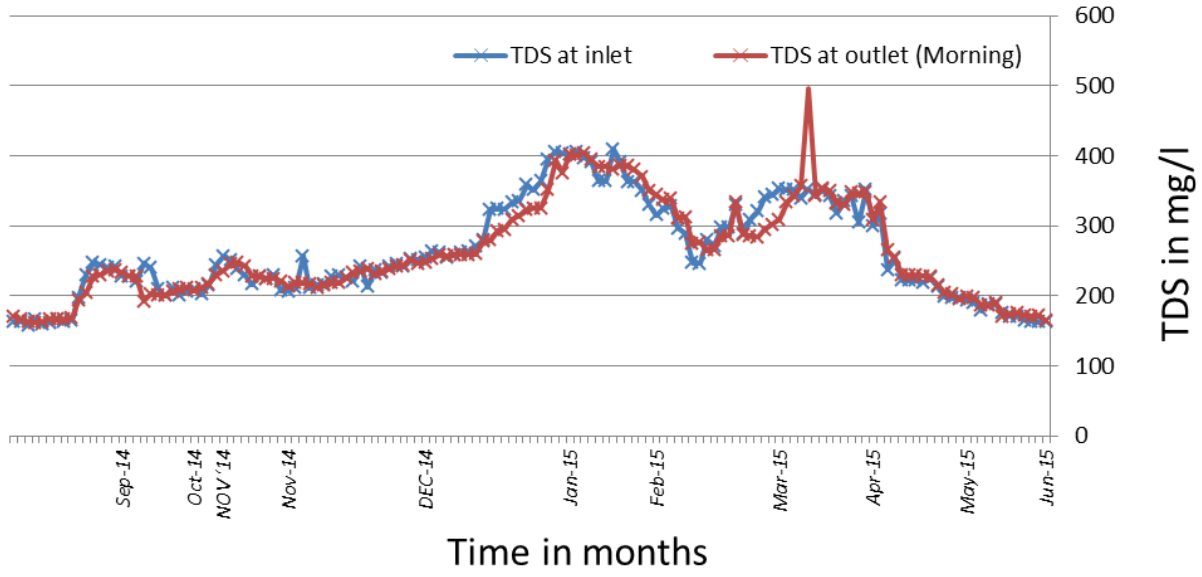

Figure 2. Variation of TDS at inlet and outlet of the WTP

c. 5.3 pH

In Figure 3, the values of pH at inlet seem to vary in a directly proportional pattern with the discharge in the river, and in increased discharge, the river turns basic due to dilution. As stated in [18 , 19], the river is highly contaminated with fecal coliforms which forces the pH of the water to drop down, the excess discharge dilutes this concentration and increases the pH values.

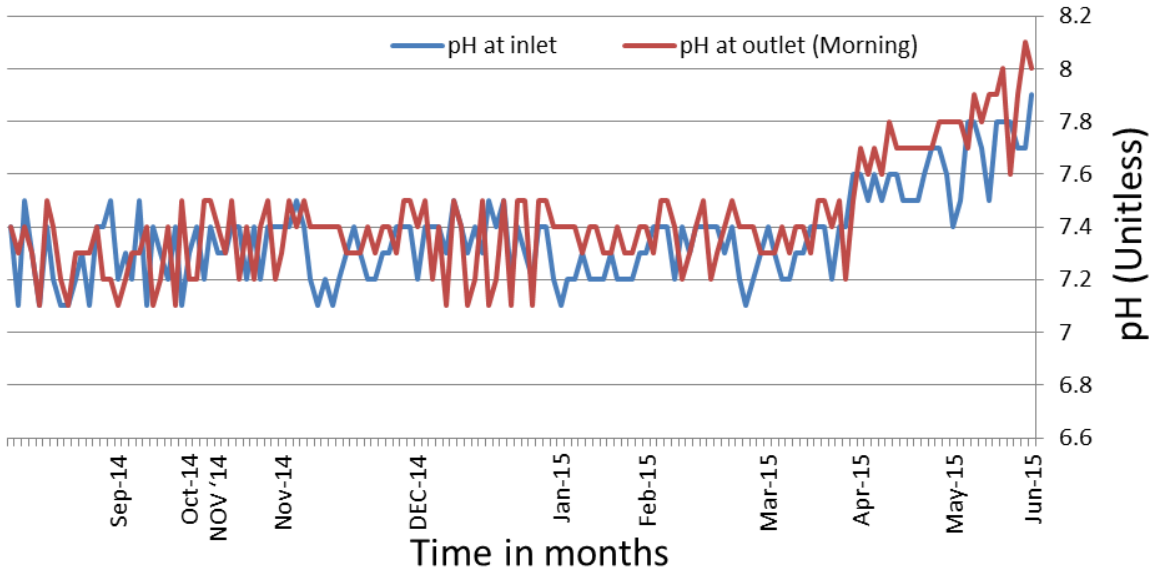

Figure 3 Variation of pH values at the inlet & outlet of WTP.

It is also observed from figure 3 that the values of pH at the inlet are slightly more than the values at the outlet of the treatment plant, which indicates improper treatment and the addition of salts inside the treatment plant. However, the values of pH at the inlet and outlet are in the limits put forward by the WHO i.e. 6.5 – 8.5 [16]. The main cause of destabilized pH values is the absence of sand filters.

d. Coliforms

From the results of Sulfur-Brath test conducted on samples, E. Coliforms were found to be present in every sample of water taken either at the inlet or at the outlet; this indicates contamination of water by fecal coliforms at the inlet and at the outlet.. [19] explains the phenomenon of contamination at the inlet source that the Indus River is polluted along all the big cities surveyed. The samples at the outlet are contaminated because water is not being treated in the treatment plant e.g. in a sand filter, nor is chlorine being added. As per WHO guidelines, there must be no biological contamination and the number of bacterial colonies must be zero [16].

e. Residual Chlorine

The Horrock's test conducted on every sample of water shows that the Residual Chlorine is absent in all the samples at the outlet, and it is equally true because the chlorination plant is not working. As per WHO guidelines, a minimum 5mg/l of chlorine must be present in the water at the outlet of a treatment plant.

f. Colour

All of the samples examined at the inlet and outlet had their tintometer tint number >60 and were found to be highly hazy. According to WHO guidelines, the water supplied must be colourless or its tintometer number must be <5 [16].

g. Odour

All of the water samples examined at the inlet and outlet had their omoscope odour threshold number >4% and were found to be highly odorous. As per WHO guidelines, the water supplied must be odourless [16].

h. Taste

All of the samples surveyed at the inlet and outlet were found to be completely unpleasant to taste. As per WHO guidelines, water must be tasteful [16].

CONCLUSIONS

From the study, it is concluded that the treatment plant is able to reduce turbidity by a great margin, but the values at the outlet are far beyond the limits guided by the WHO. The outlet values average to about 100NTU but the WHO recommends a turbidity of <5NTU at the outlet. The treatment plant doesn't treat TDS at all, but the inlet and outlet values are under the WHO limits. The maximum TDS value at the outlet is 360mg/l which is in the WHO limit of <1000mg/l. The pH values at the outlet are under the WHO guidelines of 6.5-8.5. E-Coliforms are present in every sample of water because there is no provision for biological treatment or disinfection of water. According to WHO guidelines, the water must be free of any biological contaminants. The water gets contaminated in the sedimentation tanks

due to external intrusion. Residual chlorine is not found in any of the samples because the chlorination plant is out of order. According to WHO guidelines, a minimum of 5mg/l of Cl_2 is to be present in water at the outlet. The color, taste and odour of the water at the outlet are always hazy, unpleasant and odorous. According to WHO guidelines, the water at outlet must be colourless, odourless and tasteful.

RECOMMENDATIONS

After reviewing the results of this research and the conclusions, it is recommended that to remove as much turbidity as possible and to treat the water of TDS, coagulation & flocculation must be perfectly carried out or coagulation tanks must be established, the existing sand filters must be brought to working condition, the screens and grit chambers must be introduced, and the capacity of sedimentation tanks must be increased so that the time of retention of water is increased. To stabilize the pH, odour, colour and taste of water, the slow sand filters must be established and brought to working condition so that any of the chemical and biological compounds are removed from the water. To treat the water of biological contaminants, chlorine must be added to the water in the premises of the plant and at the outlet.

It is thus inevitable to follow all the recommendations given here so that the supply of clean, treated freshwater to the public is ensured.

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